

INCENTIVES FOR EARLY ACTION AND TIMING OF GREENHOUSE GAS POLICIES FOR AGRICULTURE

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SUMMARY

The Kyoto commitment, if met, will have a significant effect on the Canadian economy and will require significant investment in most sectors. These investments once made, are sunk costs that are not recoverable. With the financial uncertainty surrounding incentives for emission reduction there is an incentive for private firms to remain flexible and delay investment until more becomes known. On the other hand, given the time and resources required to develop and adopt new technologies, it is important that some investments be initiated early. The overall costs of adjustment in the agricultural sector will be affected by the early action initiatives and the timing of policy commitments.

Very little is currently known about the timing of policies that would achieve the least cost adjustment paths in agriculture. More work is required to quantify the sources of uncertainty and how the private sector will invest given the uncertainty. A better understanding of which type of investments should be promoted immediately is also required. Finally, the timing and the type of domestic policy commitments which best address the financial uncertainty of emission reduction need to be developed.

1.0 THE ISSUE

After the commitments made in Kyoto Japan in 1997, Canada now has a significant Greenhouse Gas (GHG) emission reduction goal. Canada has agreed to reduce emissions of GHG by 6% by 2010 based on 1990 emission levels, which is 20% to 25% below business as usual scenarios. Since the emission targets come into effect in 2008, this gives Canada a relatively short amount of time to make significant adjustments in the economy. Given the short time line unnecessary delays in investment could increase the cost of achieving the

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targets. At the same time achieving the reduction targets will require substantial investments with large sunk costs. There is currently a great deal of uncertainty that surrounds the agreement, the policies, the technologies and the effects of global warming. If these investments are made before uncertainties are resolved it could result in costly stranded assets. Timing and implementation of the correct policy is therefore extremely important.

2.0 WHAT NEEDS TO BE KNOWN?

To determine what the optimal timing of policies and the incentive structures should be there are a number of factors that need to be known. The first of these is the sources, magnitude, and relative importance of uncertainty. It has been stated that uncertainty is going to play a large role especially in the adoption of GHG reducing policies in agriculture, but one still needs to know what is the actual influence of uncertainty due to these factors. How big of an impact will uncertainty over International and Domestic policy cause? What is going to be the effect if Canada waits two years to sign the Kyoto Protocol? Five years? How will uncertainty over domestic policy affect the adoption of GHG mitigating technologies in Canada?

2.1 Sources and Magnitude of Uncertainty

There are many forms of uncertainty that will affect the rate of return on investments required for GHG abatement. The rate of return will be affected by: 1) the policies introduced to reduce GHG emissions, 2) the international market place, 3) the market for emission reduction, 4) the ultimate effectiveness of the technology invested in and, 5) the impact of global warming.

2.1.1 Policy uncertainty

Uncertainty may arise for a number of different reasons. Government policy is one such factor. Dixit and Pyndyck suggest that

“... policy uncertainty may have a powerful deterrent effect on immediate investment. If governments wish to stimulate investment, perhaps the worst thing they can do is to spend a long time discussing the right way to do so.”

The uncertainty may come from either international policy or domestic policy. International policy uncertainty may include whether Kyoto will be signed, when it will be signed, and what will be the content of the final agreement. Domestic policy uncertainty may be Canadian policies implemented in response to the signing of Kyoto and what programs and policies will be pursued.

2.1.2 The international market place

The forces of globalization have increased the importance of trade and have created one large world market for many commodities. The future returns from investment will depend on this international market place. The comparative advantage of countries will be influenced by the implementation of the Kyoto accord. It is also likely that at some point that non-compliant countries will be subject to trade sanctions.

2.1.3 The market for tradable emission permits

The Kyoto agreement contains flexibility measure that among other things will create an international market for the trade of GHG emission reduction certificates. This market will create opportunities for firm to profit from the reduction in GHG. Ultimately the value of these certificates will depend on the future amounts of required emissions reductions and marginal cost of doing so.

The actual value of carbon values will also be surrounded by a great deal of uncertainty until a proper price discovery mechanism is established such as a market, cash or a futures market, for carbon. Until this mechanism is in place there is no benchmark for which to react to market conditions. At this time the estimates of price of these emission reduction certificates range from \$2 to \$100 per tonne. This wide range of estimates creates a great deal of uncertainty for those firms investing in emission reduction technologies.

2.1.4 The effectiveness of new technologies

When new technologies are developed to mitigate the effects of GHG there will most certainly be some amount of uncertainty that surrounds the ability of this new technology to alleviate GHG effects. This will cause a problem from two directions. The first is that interest groups will be reluctant to invest in these new technologies if they have not yet been proven to perform to some desired level. The second problem arises from the uncertainty of the demand

for this technology. If the interest groups are not willing to commit to purchase these new technologies then the developers of this technology will be reluctant to use resources to develop these new technologies. There is also going to be uncertainty over when the technology will be available for practical use. There is always going to be lag between when the research and development starts to when the technology is ready for use.

2.1.5 The effect global warming

The extent and effects of climate change also bring about some amount of uncertainty. There is as of yet a general consensus among professionals as to the impact and magnitude of global warming. In January of 1997 the United Nations Environment Programme's Information Unit for Conventions wrote:

"Some agricultural regions will be threatened by climate change, while others may benefit. The impact on crop yields and productivity will vary considerably. Added heat stress, shifting monsoons, and drier soils may reduce yields in tropics and subtropics, whereas longer growing seasons may boost yields in northern *Canada* and Europe. Projections of regional climate change and the resulting agricultural impacts, however, are still full of *uncertainties*." (Italics added)

In North America alone estimates on the impact of global warming on maize and wheat yields range from -55% to +62% for corn and -100% to +234% for wheat (Intergovernmental Panel on Climate Change, 1995). Such a range in yields demonstrates that there is a great deal of uncertainty surrounding the agricultural sector as to the nature and extent of global warming. One may also question whether or not action should be undertaken by countries like Canada whose agricultural sectors may actually benefit from global warming.

2.2 The Prospect of Learning

If there is a possibility of learning more about what will happen in the future there will be an incentive to delay investment and see what those future outcomes are. For example, before investing in or adopting a new technology the investor may decide to wait and see what value emission permits or carbon credits are before the investment is made. Here the prospect of learning about future events becomes important.

In other situations uncertainty will always exist and persist into the future and the prospect of learning becomes irrelevant because there is no chance of gaining more

information on the future uncertain events. The investment in this case will either take place or not take place and the decision is made independently of the uncertainty factor. As an example, consider the uncertainty surrounding the effects of weather. These uncertainties may not be resolved for a relatively long time, and as a result investment will either take place or not take place and has nothing to do with the presence of uncertainty.

2.3 The Delay Between Action and Outcomes

Since the Kyoto protocol, if signed, has some deadlines, delays between implementing a program and when the benefits are realized becomes an important factor. One of the major factors affecting the lag between when the appropriate actions have been taken and when the benefits are realized is dissemination of information. Information must reach the target group before the benefits may be realized. It is quite arguable that with something so important as global warming as an issue that not many people are aware of the possible impacts of global warming itself or the work and research that is being done to address the problem. The problem is not that there is no good information available but rather there is a problem ~~in~~ getting the appropriate information to the proper groups.

In the same heading as information dissemination, adoption of new technologies can also be grouped. There is almost always going to be a delay between when the technology is ready to be practically implemented and when it is actually adopted by the majority of the target group. This may be due to a few different factors. Some of these include availability of the new technology, uncertainty over the performance of the new technology and cost as a limiting factor in acquiring the new technology. The government may need to look at developing programs or policies that speed up the adoption process so that costly future adjustments can be avoided by ensuring that the adoption of such technologies by a certain portion of the target group occurs within a desired span of time.

Research and development of new technologies will also exhibit a delay between the primary developmental stage and when it is ready for practical use. Research and development of a new method or product usually takes a considerable amount of time and resource to bring the new technology to the market place. If this lag is found to be significantly large enough then, as in the case of information and adoption of new technologies, there may be reason for the government to intervene to overcome this barrier.

2.4 The Cost of Alternative Adjustment Paths

The rate of adjustment in emission levels will determine the rate at which new investment has to take place. In general the faster the adjustment the greater the cost of adjustment. If a large amount of investment is made in a short time period then the price of capital goods will be driven up. For example, the cost of computer programmers has risen dramatically as many firms are now addressing the year 2000 computer problems. Similarly, building methane collection systems for all hog barns in a two year period would likely be far more expensive than if the investment was spread over 10 years. These effects need to be quantified for the required investments in agriculture.

2.5 Investment Behavior of Private Firms Given Uncertainty

When considering the implementation of GHG policies it is important to discuss the investments that must be made by the appropriate groups. There are a few generalizations that can be made about these investments. The first of these is that the investments that must be made will to a certain extent be largely sunk. That is to say that when and if the invested capital is to be sold for salvage or to some other use that the cost of the capital less depreciation is not fully recovered. This will imply that before an investment is made there must be a certain amount of certainty over the future conditions or the investment will not be undertaken. For the government this means that long-term commitments must be made and adhered to or there will be less of an incentive to undertake the required investment. Making these long-term commitments contributes to reducing future uncertainty and thus reduces the incentives to delay investment.

In figure 1 investments are undertaken right away to mitigate GHG. As a result of this immediate investment emissions will start to taper off to the point where the desired emission levels are reached in 2008. After 2008 cost will start to decrease since the desired level of investment has already been reached and only upgrades and maintenance of the capital is required. Figure 2 illustrates the situation where there is a delay in investment and as a result emissions continue to rise through this period until action takes place. Once investments start to be made and costs are incurred, only then do emission levels start to fall. In this situation the end result will be the same in that the desired emission level will be reached. However, the costs incurred will be different. Since a shorter amount of time is available to make the

necessary adjustments the incremental or variable costs will be larger. Figure 3 shows the change in the capital with both certain outcomes and uncertainty. When uncertainty is present there will be an incentive to wait and find out more about the future and acquire capital at a later date. The end result will be the same amount of capital but the cost of getting there will be different with higher costs being incurred in the case where investment is delayed due to the presence of uncertainty.

2.6 The Optimal Timing and Mix of Government Policies

The overall costs of adjustment in the agricultural sector will be affected by government policy through the early action initiatives and the timing of other policy commitments. Developing the optimal timing and mix will require consideration of 1) the sources and magnitude of uncertainty, 2) the delay between action and outcomes, 3) the costs of alternative adjustment paths, and 4) the investment behavior of private firms

3.0 CURRENT KNOWLEDGE

While it has been demonstrated that there is a large number of factors that need to be known to evaluate the problem and provide the proper incentive and policy structures, there are some key items which are known. On the international policy side the emission reductions targets that were agreed to by Canada and other industrialized nations are known. The effectiveness of GHG reducing technologies is also known with some degree of certainty. This is especially true of GHG sink technologies where zero tillage and use of specialized farm machinery in agriculture has been studied for some time. The cost of these GHG reducing technologies have also been studied and documented a great deal. Looking at GHG sinks for example Lafond et al. 1993, Zentner and Lindwall 1982, Zentner and Lindwall 1978, Zentner et al. 1992, and Zentner et al. 1996 have revealed the costs and benefits associated with zero tillage on the Canadian prairies for each of the different soil zones. There is some idea as to what the adoption curves and the length of the lags look like even if they have yet to be modeled econometrically or theoretically. There is also some idea as to how actual changes in GHG concentrations will affect different areas even if currently the distribution is very wide.

4.0 WHERE DO GAPS EXIST?

There are still many gaps between what the sources, magnitudes, and relative importance of uncertainty as a factor are. To determine what the optimal program of policies are, the gaps between what is known and what needs to be known must be filled. The stance that is going to be taken on this issue of GHG reduction by Canada both Internationally and Domestically still needs to be clarified. The government has yet to send a strong signal that suggests its intentions. How is it going to be handled Domestically? Will it be controlled by the Federal or Provincial governments or both? What are the penalties going to be if Canada or another nation fail to meet their reduction goals? The extent and effects of climate change have yet to be refined to a level that is reasonable to make estimates and run meaningful simulations. The impact on Canada directly is one area that definitely needs more consideration since it may be the case the increase in GHG concentration may give Canadian agriculture a definite advantage in the future and pursuing GHG reducing policies may not be in Canada's best interests nationally. A market to determine the value of emissions has not yet been developed to let the market determine what the private value of GHG is or will be under some type of policy regime. The type and timing of new technologies are still not to the point where the performance and feasibility of such technologies are known with certainty.

Lags and least cost paths for adjustment need to be studied in more detail to determine the appropriate relationships needed to develop optimal policies. One of the major issues that has yet to receive much attention is how investment behavior, intellectual or physical capital, is affected by uncertainty when dealing with GHG emission reductions. Information dissemination is another factor that needs to be studied and evaluated if a correct prediction of adoption paths may be made. It is very unclear at this time what type of enforcement, if any, is needed to regulate new capital.

5.0 CONCLUSIONS

The implementation of GHG policies to meet Canada's emission reduction levels as outlined by the Kyoto protocol are hindered by a number of different factors. The major factors influencing the achievement of these goals are uncertainty, realizing the delays between

action and outcomes, and determining the optimal approach to policy intervention and incentive and penalty structures. To determine the optimal approach requires sound knowledge of a great many factors including whether or not Canada's agricultural sector should be pursuing a program that could potentially limit future gains that may be had by increased levels of GHG in the atmosphere. While a small number of the important factors are known with some degree of uncertainty, a lot of work has yet to be done to determine what is the best course of action for Canada's agricultural sector to take.

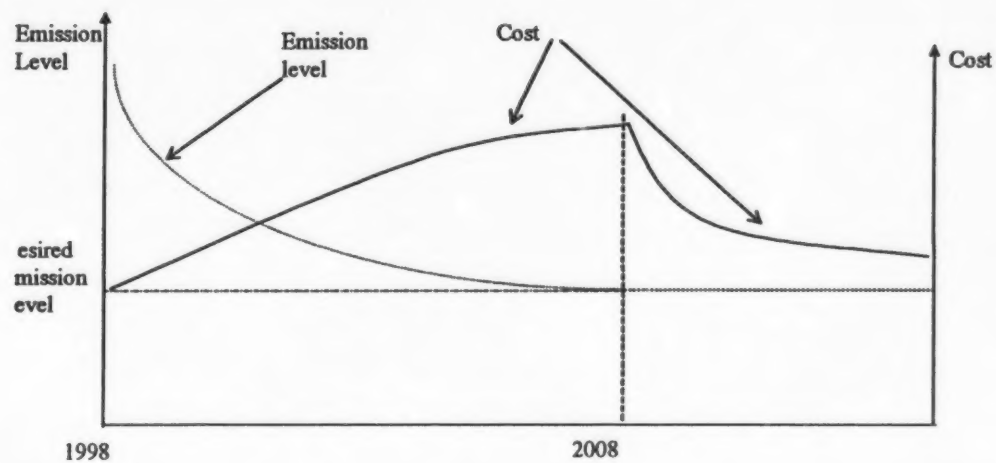


Figure 1: Cost vs. Emission Levels with Immediate Investment

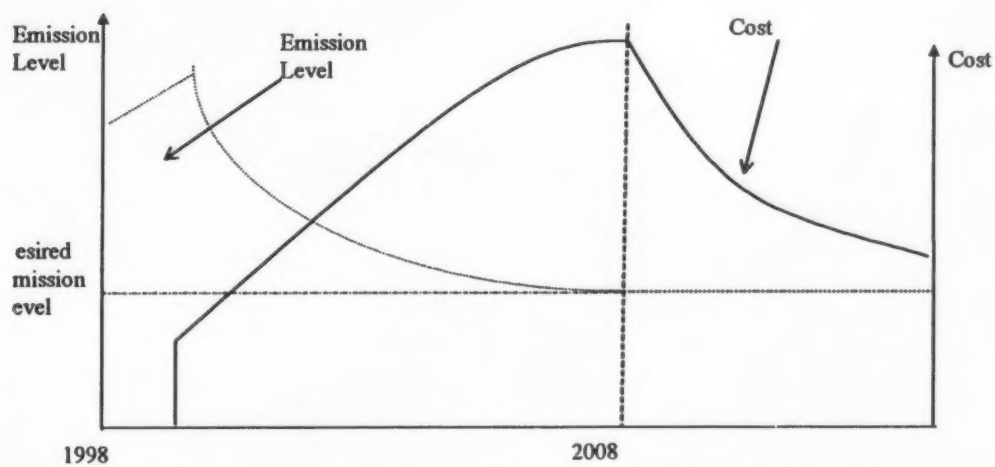


Figure 2: Cost vs. Emission Levels with Delayed Investment

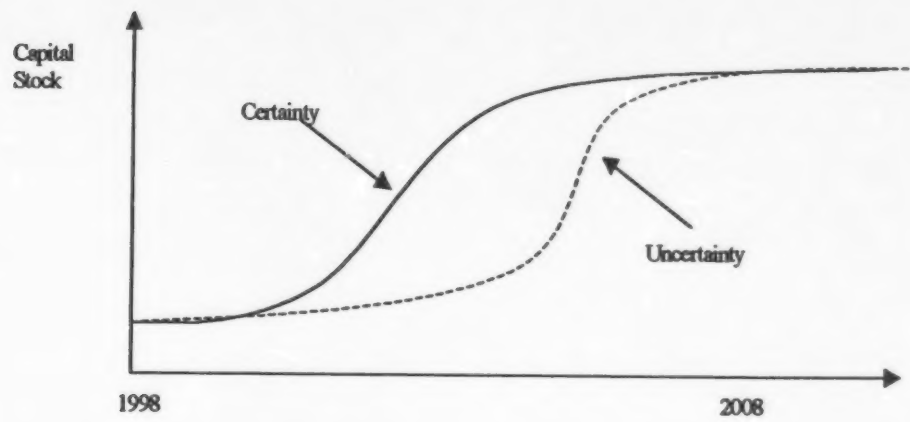


Figure 3: Total Capital Stock under Certainty and Uncertainty

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